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PART II

# ENVIRONMENTAL PROTECTION AGENCY

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# LANDFILL DISPOSAL OF SOLID WASTE

## Proposed Guidelines

[6560-01-M]

## ENVIRONMENTAL PROTECTION AGENCY

[40 CFR Part 241]

[Docket No. 1008.1; FRL 1063-5]

### LANDFILL DISPOSAL OF SOLID WASTE

#### Proposed Guidelines

AGENCY: Environmental Protection Agency.

ACTION: Proposed rule.

SUMMARY: These Guidelines are issued under Section 1008(a)(1) of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, Pub. L. 94-580, 90 Stat. 2803, 42 U.S.C. 6907(a) (the Act). The Guidelines describe recommended considerations and practices for the location, design, construction, operation and maintenance of solid waste landfill disposal facilities.

DATES: Comments are due May 25, 1979. Hearings: Hearings will be held on May 15, 1979, and May 17, 1979.

ADDRESSES: The mailing address for all comments is Office of Solid Waste (WH-564) Environmental Protection Agency, Washington, D.C., 20460; Attention: Bernard Stoll, Docket 1008.1.

The official record for this rulemaking (Docket Number 1008.1) is located in Room 2107, EPA, 401 M Street, SW., Washington, D.C. 20460, and is available for viewing from 9:00 a.m. to 4:00 p.m., Monday through Friday excluding holidays.

Hearings: Two hearings on this Section 1008(a) proposal are scheduled as follows:

May 15, 1979—EPA Waterside Mall, Room 3906, 401 M Street SW., Washington, D.C. (9:00 am to 4:00 pm).

May 17, 1979—Shamrock Hilton, 6900 South Main at Holcombe Blvd., Houston, Texas (9:00 am to 4:00 pm).

Registration will begin at 8:30 am at each location. Anyone wishing to make an oral statement(s) at the hearing(s) should notify, in writing: Mrs. Geraldine Wyer, Public Participation Officer, Office of Solid Waste (WH-562), U.S. EPA, Washington, D.C. 20460.

Oral or written comments may be submitted at the public hearings. Persons who wish to make oral presentations must restrict their presentations to ten minutes, and are encouraged to have written copies of their complete comments for inclusion in the official record.

FOR FURTHER INFORMATION CONTACT:

Mr. Bernard Stoll, Office of Solid Waste (WH-564), U.S. EPA, Washington, D.C. 20460, (202) 755-9116.

#### PURPOSE

Section 1008(a)(1) of the Act directs the Administrator to publish "suggested guidelines" that "provide a technical and economic description of the level of performance that can be attained by various available solid waste management practices (including operating practices) which provide for the protection of public health and the environment." The legislative history of this provision indicates that such Guidelines are to provide information to the States about alternative solid waste management practices. This information will assist the States in their solid waste management planning.

The purpose of these Guidelines is to suggest preferred methods for the design and operation of those solid waste disposal facilities which employ landfilling techniques. The decision as to what mix of these and other practices will be required to meet regulatory standards for land disposal will be a matter of State concern.

These guidelines replace 40 CFR Part 241—"Guidelines for the Land Disposal of Solid Wastes"—dated August 14, 1974, which were developed under the authority of the Solid Waste Disposal Act, as amended by the Resource Recovery Act of 1970 (Pub. L. 91-512).

#### APPROACH

There are two aspects to the information provided in conjunction with these Guidelines. First, EPA has identified a set of available landfill practices which are aimed at protecting public health and the environment. Second, it has provided a technical and economic description of those practices where such a description was possible.

However, to facilitate the clarity of its presentation and avoid redundancy EPA has chosen to identify the landfill practices in the text of the Guidelines and provide a more specific description of the technical and economic aspects of each practice in the voluntary Environmental and Economic Impact Statement (EIS) prepared in conjunction with the Guidelines. The Guidelines do incorporate the discussion found in the EIS. In § 241.207 the Guidelines indicate what portion of the EIS provides an elaborated description of each landfill practice. EPA believes this approach avoids unnecessarily repeating the information in both documents and makes the text of the Guidelines a more concise summary of sound landfilling practices. In keeping with this approach EPA solicits comment on both the Guidelines and those parts of the EIS that provide supplemental detail on the suggested landfill practices.

#### COVERAGE

These Guidelines are applicable to all solid waste disposal operations which involve the burial of solid waste. They do not apply to solid waste disposal operations which involve the landspreading or surface impoundment of solid waste. Separate guidelines for landspreading and surface impoundment disposal will be promulgated at a later time.

The Guidelines have been developed to provide information applicable to new and existing landfills. All sections of the Guidelines are applicable to new facilities, while all sections except § 241.200 (Site Selection) provide information relevant to the expansion or modification of existing landfills. EPA chose this approach because it would have been unnecessarily duplicative to develop separate sections of the Guidelines for new and existing facilities.

#### RELATIONSHIP TO OTHER REGULATIONS

Subtitle D of RCRA—The "Criteria for Classification of Solid Waste Disposal Facilities," to be promulgated under Sections 4004 and 1008(a)(3) of the Act, will establish performance standards (based on environmental effects) for facilities for the land disposal of solid waste. Facilities which cannot meet the Criteria standards are "open dumps" according to Section 4005(a) and will be subject to the requirements authorized under Subtitle D for such sites. The Guidelines proposed here should not be confused with the Criteria.

The Criteria are designed to define the level of health and environmental protection which a land disposal facility must achieve to avoid designation as an "open dump." The test for compliance with the Criteria is whether there will be "no reasonable probability of adverse effects on health or the environment" associated with disposal of solid waste at a facility. This is a case by case decision which requires cognizance of the particular circumstances found at each site. The Guidelines identify and describe available solid waste management practices which provide for the protection of public health and the environment.

In promulgating these Guidelines EPA is certifying that they represent sound solid waste management practices, and in many cases compliance with the Criteria can be achieved by applying practices outlined in the Guidelines. However, use of practices described in the Guidelines does not provide a general guarantee of a site's compliance with the Criteria. The relationship between these Guidelines and the Criteria of Subtitle D is that the Guidelines are an informational resource which can assist State officials and site operators in determining

the particular set of solid waste management practices which are needed to achieve compliance with the Criteria at each site. A site could also satisfy the Criteria by employing an approach not discussed in the Guidelines, such as a new innovative technology.

Subtitle C of RCRA—Under Section 3004 of the Act EPA establishes standards concerning treatment, storage and disposal at hazardous waste facilities. EPA proposed regulations, on December 18, 1978 (43 FR 58946), which specify practices required at facilities for the disposal of hazardous waste. These Guidelines should not be confused with those standards. These Guidelines provide general information about alternative landfilling practices. The final regulations issued under Section 3004 will define the disposal responsibility of hazardous waste facilities. Thus, the information in these Guidelines is only relevant to a hazardous waste facility to the extent that it provides an explanation of practices required under Section 3004 of the Act.

Other Environmental Regulations—Disposal of solid waste in landfills may affect public health and the environment such that standards established under other statutes are violated. It should be clear that sound landfilling practices cannot include practices which violate environmental regulations designed to protect public health and the environment. Therefore, at a minimum, landfill practices should comply with all standards established under Federal and State law. In particular landfill operators should assure that their facilities comply with applicable portions of the Clean Water Act, as amended, 33 U.S.C. Section 1251, *et seq.*, The Safe Drinking Water Act, as amended, 42 U.S.C. Section 7401, *et seq.*, The Occupational Safety and Health Act, as amended, 29 U.S.C. Section 651, *et seq.*, and the Endangered Species Act, as amended, 16 U.S.C. Section 1530, *et seq.*

### Discussion of Proposed Guidelines

*Definitions*—All definitions contained in the Resource Conservation and Recovery Act of 1976 (Pub. L. 94-580) apply in these Guidelines. The definition for "hazardous waste" given at Section 1004(5) of the Act is further defined by regulations proposed under the authority of Section 3001(a), December 18, 1978 (43 FR 58946).

The definition of "sole source aquifiers" is derived from Section 1424(e) of the Safe Drinking Water Act of 1974 (Pub. L. 93-523).

The definition of "ten-year 24 hours precipitation event" is taken from "Effluent Limitations Guidelines for Existing Sources—Coal Mining Point Source Category" (40 CFR 434).

The definition of "wetlands" was taken from the Army Corps of Engineers "Permits for Discharges of Dredged or Fill Material into Waters of the United States" (33 CFR 323.2(c)).

*Site Selection*—Section 241.200 concerns the location of landfill disposal facilities. This section emphasizes that the selection of a site for the landfill disposal of solid waste should be accomplished in consideration of the areal ground and surface water conditions; geological and topographical features; social, geographic and economic factors; and environmental impacts. This section suggests avoidance of environmentally sensitive areas (wetlands, floodplains, critical habitats of endangered species, permafrost areas and recharge zones of sole source aquifiers). This section further indicates that zones of active faults and karst terrain are areas that should, similarly, be avoided.

Surficial disturbances by active faults may result in shifts in waste disposal sites which may damage any liners used or expose disposed solid waste.

Karst terrain is terrain which has been formed over limestone, dolomite or gypsum as a result of solution processes; it is characterized by closed depressions or sink holes, caves and solution channels and commonly has underground drainage. Disposal of solid wastes on such terrain faces potential problems distinctive to this unique geological setting: (1) leachate produced at the site may be channeled without attenuation via solution cavities beneath the site into ground water and transported rapidly over substantial distances to unpredictable locations, and (2) a cavern or sink hole beneath the site can, in effect, ingest disposed wastes into the ground-water channels within the bedrock.

These Guidelines, however, recognize that location of a landfill disposal facility in a generally unsuitable area (environmentally sensitive areas, zones of active faults, and karst terrain), if no other feasible alternative exists, may be possible through the application of proper, and in some cases sophisticated, engineering techniques for design and operation.

*Design*—This section of these Guidelines is a straightforward discussion and reiteration of the various topics which should be considered and addressed during the design stage of landfill development. It emphasizes the value of a clear presentation of all design features in appropriate plans to facilitate review by the appropriate regulatory authority, as well as to facilitate operation in accordance with the original design. This section further cautions that each design feature must be reviewed in light of each other design feature to enable appropriate "trade-off" analyses and decisions.

*Leachate Control*—This section of these Guidelines addresses The potential for adverse impact on ground and surface water by landfill disposal of solid waste. These Guidelines explain that the most protective means for leachate control involves the application of techniques to achieve containment of the disposed solid waste through placement of very low permeability materials on the bottom and sides of a landfill and sealing of the surface of the completed landfill.

These Guidelines recognize, however, that containment techniques may not be necessary nor appropriate at all landfill disposal facilities since some degree of attenuation of contaminants found in landfill leachate can be expected in both the unsaturated and saturated zones underlying a landfill disposal facility. These Guidelines suggest the acceptability of both controlled and uncontrolled release of landfill leachate provided there is a demonstration of the needed attenuative capacity in the unsaturated and saturated zones beneath the landfill sufficient to avoid an adverse effect on the ground water. Since procedures for estimating the attenuative capabilities of underlying soils and ground water have not achieved wide acceptance, such estimates may be possible only with a thorough knowledge of the solid waste to be disposed in conjunction with site-specific hydrogeological and climatological conditions.

Comments are requested on the acceptability of this approach in these Guidelines and on information regarding prediction techniques for soil attenuation and ground water contamination.

This section recognizes that control of infiltration of precipitation into a landfill is a means of reduction or control of leachate generation. These Guidelines, therefore, suggest diversion of surface runoff away from or around the landfill. The recommendation of the ten year 24 hour precipitation event for diversion structure design is based on the wide acceptance of this engineering design criterion.

This section explains the purpose and uses of landfill liner materials, both natural and synthetic. Information on the long-term integrity of liner materials is limited, although research on this subject is now underway. In recognition of the site-specific nature of each liner application, these Guidelines do not specify liner thicknesses and permeabilities for various applications. The degree of containment or rate of release required and the desired time of first appearance of leachate at the bottom of the liner dictate the type and thickness of materi-

al for each application. Low permeability liner materials are specified as those with permeability equal to or less than $1 \times 10^{-7}$ cm/sec, which is typical of tight clay soils.

While polymeric liner materials are frequently attributed a permeability of less than $1 \times 10^{-12}$ cm/sec, no such specification is included in these Guidelines. Falling head or constant head permeameters are typically used in the laboratory to determine the permeability of soil materials. This apparatus is unusable for polymeric film materials and no equivalent test for direct measurement of the permeability of these materials has, as yet, been perfected.

The specification of minimum thicknesses for soil and synthetic membrane liners were included in these Guidelines in recognition of current construction techniques and practices. In the case of soil liners, the one foot minimum thickness should avoid the possibility of sections of the liner being inadvertently placed at thicknesses of only an inch or two in some places due to irregularities in the surface of the sub-base and the insensitivity of some construction equipment. The 20 mil minimum thickness for synthetic membranes is included to reflect concern for protection against tears in the membrane during installation.

Where a liner is used to minimize the exfiltration of landfill leachate to underlyings soils, these Guidelines suggest continuous removal of collected leachate in order to limit the head of leachate on the liner to the shallowest possible depth. This recommendation can be more simply stated that the less leachate allowed to remain atop the liner the less is available to leach through the liner. These Guidelines also present in this section the limited available information on the effectiveness of leachate treatment and disposal technology.

EPA particularly invites comment on the approach and information in this section.

*Gas Control*—This section of these Guidelines addresses the potentially dangerous conditions which may result from migration of methane gas generated within a landfill from biological degradation of disposed organic solid waste. This section also recognizes the potential occurrence and migration of other dangerous gases from volatile solid waste and chemical reactions among disposed wastes.

This section emphasizes the need to consider the consequences of selection of individual control techniques. For example, a decision to minimize leachate generation by sealing the surface of a completed landfill disposal facility can only be made after consideration of the need to provide some means of venting gases which may be generated.

Assessments of current technology for gas migration control, both active and passive systems, are included in this section.

*Runoff Control*—This section is included to call attention to the need to provide for control of runoff of surface water from precipitation on the landfill, as well as the area surrounding the landfill. In addition to minimizing the quantity of water available for infiltration into a landfill, surface runoff control is necessary to minimize the erosion of soil. This section also explains that runoff which has not been contaminated by solid waste or leachate may still need to be introduced into a surface impoundment designed to allow settling of eroded sediment.

*Operation*—This section of these Guidelines presents appropriate considerations for the proper and safe operation of a landfill disposal facility. The importance of application of daily and final cover material is presented along with achievable benefits. Much of this section addresses safety considerations for both employees and users of the landfill disposal facility. Guidance for closure and long term maintenance of completed landfill disposal facilities is not included in this section. Such procedures are left to the appropriate regulatory authority. EPA intends in the future to develop guidance on this subject.

*Monitoring*—This section of these Guidelines presents a brief overview of considerations for monitoring the performance of landfill disposal facilities. This section's lack of specificity is in recognition of the site-specific nature of the design and installation of a monitoring system at a landfill. In most cases the need for and degree of monitoring required is at the discretion of the appropriate regulatory authority. This section does include, however, a specific caution against installation of ground-water monitoring wells through the landfill proper. Such monitoring wells may provide a conduit for direct transmission of landfill leachate to underlying ground water.

ENVIRONMENTAL AND ECONOMIC IMPACTS

In accordance with Executive Order 11821, as amended by Executive Order 11949, and EPA Policy as stipulated in 39 FR 37419, October 21, 1974, environmental and economic impact analyses on these Guidelines have been performed and are available as the "Draft EIS on the Proposed Guidelines for the Landfill Disposal of Solid Waste" from the Office of Solid Waste (WH-564), U.S. EPA, Washington, D.C. 20460.

The Draft EIS also serves as the principal background document in support of these Guidelines. The final version of this EIS will be issued at the time of promulgation.

Dated: March 19, 1979.

DOUGLAS M. COSTLE,
*Administrator.*

It is proposed to amend Title 40, CFR, Part 241 to read as follows:

## PART 241—GUIDELINES FOR THE LANDFILL DISPOSAL OF SOLID WASTE

Sec.

241.100 Scope.
241.101 Definitions.
241.200 Site Selection.
231.200-1 General.
241.200-2 Recommended Practices.
241.201 Design.
241.201-1 General.
241.201-2 Recommended Practices.
241.202 Leachate Control.
241.202-1 General.
241.202-2 Recommended Practices.
241.203 Gas Control.
241.203-1 General.
241.203-2 Recommeded Practices.
241.204 Runoff Control.
241.204-1 General.
241.204-2 Recommended Practices.
241.205 Operation.
241.205-1 General.
241.205-2 Recommended Practices.
241.206 Monitoring.
241.206-1 General.
241.206-2 Recommended Practices.
241.207 Use of Environmental Impact Statement.
241.207-1 General.
241.207-2 Recommended Practices.

AUTHORITY: Sec. 1008(a)(1) of the Solid Waste Disposal Act of 1965 (Pub. L. 89-272) as amended by the Resource Conservation and recovery Act of 1976 (Pub. L. 94-580).

### § 240.100 Scope.

(a) These Guidelines apply generally to disposal of solid waste in landfills. The Guidelines describe practices and considerations which seek to protect public health and the environment.

(b) The "Criteria for Classification of Solid Waste Disposal Facilities," promulgated under Section 4004 of the Act, establish performance standards for the land disposal of solid waste. The Criteria identify the level of performance necessary to assure that no reasonable probability of adverse effects on health or the environment will result from disposal of solid waste at such facility. At a minimum disposal of solid waste in landfills should achieve compliance with the Criteria. These Guidelines describe alternative landfill disposal operations that are designed to protect public health and the environment. These Guidelines provide valuable information which should assist responsible agencies in making case by case determinations on compliance with the Criteria. In many cases compliance with the Criteria. In

many cases compliance with the Criteria can be achieved by applying practices outlined in the Guidelines. However, use of practices described in the Guidelines does not guarantee compliance with the Criteria. Practices recommended in the Guidelines are not meant to be exclusive or to discourage the development and use of equally effective technologies.

(c) Hazardous waste disposal facilities are subject to the standards developed under section 3004 of the Act. These Guidelines are relevant to hazardous waste facilities only to the extent that they provide information about practices necessary to comply with section 3004.

**§ 241.101 Definitions.**

As used in these Guidelines:

(a) "Aquifer" means a geologic formation, group of formations, or part of a formation that is capable of yielding usable quantities of ground water to wells or springs.

(b) "Attenuation" means any decrease in the maximum concentration or total quantity of an applied chemical or biological constitutent in a fixed time or distance traveled resulting from physical, chemical and/or biological reaction or transformation.

(c) "Base flood" means a flood that has a 1 percent or greater chance of recurring in any year or a flood of a magnitude equalled or exceeded once in 100 years on the average over a significantly long period. In any given 100-year interval such a flood may not occur, or more than one such flood may occur.

(d) "Cell" means the daily volume of solid wastes that are deposited and enclosed by cover material in a landfill disposal facility.

(e) "Contamination" means the degradation of naturally occuring water, air or soil quality either directly or indirectly as a result of man's activities.

(f) "Contingency Plan" means an organized, planned, coordinated course of action to be followed in the event of a fire, explosion or discharge or release of waste into the environment which has the potential for endangering human health and the environment. Financial planning to identify resources for initiation of such action is a part of contingency plan development.

(g) "Cover material" means soil or other suitable material that is spread and compacted on the top and side slopes of disposed solid waste in order to: control vectors, gases, erosion, fires, and infiltration of precipitation; support vegetation; provide trafficability; or assure an aesthetic appearance.

(h) "Disposal" means the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters (Pub. L. 94-580, 90 Stat. 2799, 42 U.S.C. 6903).

(i) "Facility structures" means any buildings or other structures, or utility or drainage lines on the landfill disposal facility.

(j) "Floodplain" means the lowland and relatively flat areas adjoining inland and coastal waters, including floodprone areas of offshore islands, which are inundated by the base flood.

(k) "Ground water" means water below the land surface in the zone of saturation.

(l) "Hazardous waste" means those wastes identified by list or by characteristic in regulations promulgated pursuant to section 3001 of Pub. L. 94-580.

(m) "Landfill" means a facility for the disposal of solid waste involving the placement of solid waste on or into the land surface, and usually involving compaction and covering of the disposed solid waste, and which is not a landspreading or surface impoundment facility.

(n) "Leachate" means liquid containeing dissolved or suspended materials that emerges from solid waste.

(o) "Liner" means a layer of emplaced materials beneath a landfill which serves to restrict the escape of wastes or their constituents from the landfill.

(p) "Monitoring Well" means a well used to obtain water samples for water quality analysis or to measure groundwater levels.

(q) "Open burning" means the combustion of solid waste without (1) control of combustion air to maintain adequate temperature for efficient combustion, (2) containment of the combustion reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion, and (3) control of the emission of the combustion products.

(r) "Open dump" means a site for the disposal of solid waste which does not comply with the "Criteria for Classification of Solid Waste Disposal Facilities". (40 CFR 257).

(s) "Periodic application of cover material" means the application of soil or other suitable material over disposed solid waste at such frequencies and in such a manner as to control vectors and infiltration of precipitation; reduce and contain odors, fires, and litter; and to enhance the facility's appearance and future utilization.

(t) "Permafrost" means permanently frozen subsoil.

(u) "Plans" means technical reports and engineering drawings, including a narrative operating description, prepared by professionals which properly describe and record the landfill disposal facility and its proposed operation.

(v) "Potential zone of influence" means that area within a water resource which could be contaminated by leachate or other materials derived from a landfill disposal facility.

(w) "Recharge zone" means an area through which water enters an aquifer.

(x) "Responsible agency" means any organization that has the legal duty to ensure that owners, operators or users of land disposal sites comply with these guidelines or other applicable regulations.

(y) "Runoff" means the portion of precipitation that drains from an area as surface flow.

(z) "Salvaging" means the controlled removal of waste materials for utilization.

(aa) "Sanitary landfill" means a facility for the disposal of solid waste which meets the "Criteria for Classification of Solid Waste Disposal Facilities" (40 CFR 257).

(bb) "Scavenging" means uncontrolled removal of solid waste materials.

(cc) "Sludge" means any solid, semisolid, or liquid waste generated from a municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effects (Pub. L. 94-580, 90 Stat. 2800, 42 U.S.C. 6903).

(dd) "Sole Source Aquifers" means those aquifers, designated pursuant to Section 1424(e) of the Safe Drinking Water Act of 1974 (Pub. L. 93-523), which solely or principally supply drinking water to a large percentage of a populated area.

(ee) "Solid waste" means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923). (Pub. L. 94-580, 90 Stat. 2801, 42 U.S.C. 6903).

(ff) "State" means any of the several States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American

Samoa, and the Northern Mariana Islands. (Pub. L. 94-580, 90 Stat. 2801, 42 U.S.C. 6903).

(gg) "Ten-year 24 hour precipitation event" means the maximum 24 hour precipitation event with a probable reoccurrence interval of once in 10 years as defined by the National Weather Service and Technical Paper No. 40, "Rainfall Frequency Atlas of the U.S." May 1961, and subsequent amendments, or equivalent regional or rainfall probability information developed therefrom. (40 CFR Part 434—Coal Mining Point Source Category—Effluent Limitations Guidelines for Existing Sources).

(hh) "Vector" means a carrier that is capable of transmitting pathogens from one organism to another.

(ii) "Water table" means the upper surface of the zone of saturation in an unconfined aquifer at which the pressure is equal to atmospheric pressure.

(jj) "Wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. (33 CFR Part 323—Permits for Discharges of Dredged or Fill Material into Waters of the United States).

### § 241.200 Site selection.

### § 241.200-1 General.

Selection of a site is the most critical step in establishing a landfill disposal facility. Site selection must be accomplished in consideration of: ground and surface water conditions; geology, soils and topographic features; solid waste types and quantities; social, geographic and economic factors, and aesthetic and environmental impacts.

### § 241.200-2 Recommended practices.

Site selection should be accomplished in accordance with the following:

(a) Environmentally sensitive areas, including wetlands, 100-year floodplains, permafrost areas, critical habitats of endangered species, and recharge zones of sole source aquifers should be avoided or receive lowest priority as potential locations for landfill disposal facilities. If these areas are to be considered the following subjects need to be addressed:

(1) *Alternatives.* Before concluding that location of a landfill in an environmentally sensitive area is advisable, alternative locations and disposal techniques should be evaluated in terms of hydrogeologic, technological, environmental, economic and other pertinent factors. Alternatives involving regional facilities, resource recovery, or both, should also be considered. Increased costs, alone, should not be sufficient grounds for dismissing an alternative in favor of disposal in an environmentally sensitive area.

(2) *Impact.* A comprehensive analysis of location of a landfill in an environmentally sensitive area should be performed and provided to the responsible agency or agencies along with the discussion of alternatives. Such analyses should include: an estimate of the type and extent of potential impact on the ecosystem; consideration of design, construction and maintenance techniques to minimize, prevent or correct such impacts; and a general appraisal of the area in terms of rate of encroachment, cumulative impact, and multiplier effect of activities in that area.

(3) *Approvals.* Disposal into waters of the United States, including wetlands, is subject to provisions of the Clean Water Act, as amended, 33 U.S.C. 1251 *et seq.* If disposal operations jeopardize the continued existence of endangered and threatened species, such operations may constitute a violation of the Endangered Species Act, as amended, 16 U.S.C. 1530 *et seq.* Proper site selection must include compliance with applicable requirements of those laws, as determined by the responsible State or federal authorities.

(b) Zones of active faults and karst terrain should be avoided in locating landfill disposal facilities unless a site-specific evaluation demonstrates minimum potential for adverse effects, especially upon ground water.

(c) The cost effectiveness of a site's selection should be determined, if considered environmentally feasible. This cost analysis should include not only the economics of the disposal facility operation but also the impact of the planned future use of the site after completion of landfill operations.

(d) The possible incorporation of a site into a regional solid waste disposal system whether currently in existence or a future possibility, should be considered during environmental and economic evaluations. Furthermore, programs for the location, design and operation of solid waste facilities should be consistent with residual waste disposal programs developed pursuant to section 208(b)(2)(J) of the Clean Water Act and § 35.1519-6(f) of the Proposed Water Quality Management Regulations (43 FR 40752, September 12, 1978).

(e) Sites traversed by pipes or conduits (for sewage, storm water, etc.) should be rejected unless their relocation or protection is feasible. Since such pipes may serve as pathways for gas and leachate extreme caution must be observed and a plan for pipe maintenance and repair developed.

(f) Characteristics and availability of on-site soil should be evaluated with respect to their effects on site performance and site operations, such as, use of the soil for cover material and soil suitability for vehicle maneuverability.

(g) Sites located in the vicinity of airports, where birds attracted to the landfill disposal facility could pose a hazard to aircraft, should be avoided.

(h) Sites should be accessible to appropriate vehicles by all-weather roads leading from the public road system.

(i) The potential socio-economic effects of a site's selection should be determined. Topics to be addressed include aesthetic and safety considerations such as vehicular traffic, litter, noise and other possible nuisance conditions.

### § 241.201 Design.

### § 241.201-1 General.

Sufficient design is essential to the successful operation of a facility in even the best location. In the design phase of a landfill disposal facility all the requirements and technology alternatives to satisfy those requirements are reviewed prior to incorporation into the design. The design involves the evaluation and documentation of a landfill capable of accepting certain solid waste materials for disposal.

### § 241.201-2 Recommended practices.

A landfill disposal facility should be designed in accordance with the following:

(a) The types and quantities of all solid waste expected to be disposed at the landfill should be determined by survey and analysis to serve as a basis for design.

(b) Current and projected use of ground-water resources in the vicinity of the landfill disposal facility should be determined as a basis for design of any necessary ground-water protection and monitoring system as follows:

(1) Establish initial (background) quality of water resources in the potential zone of influence.

(2) Establish the depth to the water table and the direction and rate of ground-water flow with special consideration of current and projected withdrawal rates by ground-water users.

(3) Establish potential interactions of the landfill disposal facility, its hydrogeology, and the areal ground and surface waters, based upon historical records and other sources of information.

(4) Establish site geology, at least down to the mean annual water table with specific emphasis on hydraulic conductivity and the possible natural

attenuative capacity of the soils and subsurface geology.

(c) Quality, quantity, source and seasonal variations of surface waters in the vicinity of the landfill disposal facility should be established to serve as a basis for design of any necessary surface water protection and monitoring system.

(d) The nearby floodplain (defined by the 100 year flood level) should be established in accordance with procedures described in "Guidelines for Determining Flood Flow Frequency," Bulletin No. 17a, Water Resources Council, Hydrology Committee, June 1977. If all or part of the facility lies within the 100 year flood plain a suitable dike to prevent facility inundation should be detailed in the site design.

(e) A water balance for the landfill disposal facility should be established to serve as a basis for design of leachate control and surface runoff systems. The method contained in "use of the Water Balance Method for Predicting Leachate Generation from Solid Waste Disposal Sites" (SW-168) is an example of a technique for accomplishing this.

(f) Landfill leachate generation cannot be avoided except in some arid climates, therefore, leachate control measures for water quality protection should be incorported in the site design, as required (re: § 241.202).

(g) Since most organic waste material undergoes decomposition in a landfill, decomposition gas will be generated. The landfill design should include measures for control of these and other potential gaseous emissions, as required (re: § 241.203).

(h) The final design of a landfill disposal facility can only be accomplished after a thorough analysis of tradeoffs among environmental impacts, economic considerations, future use alternatives and nature and quantities of the waste to be disposed has been accomplished. This tradeoff analysis cannot be overemphasized in light of potentially conflicting landfill control technologies. For example, minimization of leachate generation can be accomplished, in part, by sealing the surface of a landfill, however, the surface seal will effectively minimize escape of decomposition gases from the landfill which may result in potentially dangerous off-site gas migration. Selection of control technologies, therefore, must consider the impact of companion technologies at a landfill disposal facility and be compatible with the planned end use of the site.

(i) Plans for design, construction, operation and maintenance of new sites or modifications to existing sites should include:

(1) Evidence of compliance with applicable State and Federal regulations.

(2) Demonstrated consistency with the "Recommended Practices" of these guidelines, or suitable alternative technologies.

(3) Careful detailing of all design and operational considerations necessary to bring site conditions to an acceptable level.

(4) A clear presentation and discussion of any separate areas which have been incorporated into the landfill design for disposal of specific wastes requiring special or separate handling.

(5) Other pertinent information, such as:

(i) Initial and final topographies at contour intervals of 5 feet or less as specified by the appropriate regulatory authority.

(ii) Land use and zoning within, at least, one-quarter mile of the site showing the location of all residences, buildings, public and private wells, water courses, rock outcroppings, roads.

(iii) Location of all airports within two (2) miles of the site.

(iv) Location of all utilities within, at least, 500 feet of the site.

(v) Temporary and permanent all weather access roads.

(vi) Screening and other nuisance control measures.

(vii) Site monitoring locations.

(viii) Sedimentation control plans.

(ix) Narrative descriptions, with associated technical drawings, indicating site development and operation procedures.

(x) Contingency plans.

(xi) Projected use of completed site.

(xii) Long term maintenance procedures.

**§ 241.202 Leachate control.**

**§ 241.202-1 General.**

Entry of landfill leachate into ground or surface water may result in an adverse impact upon those waters. Landfill leachate management techniques include control of leachate production, control of escape of leachate from a landfill and control of the impact of leachate on the environment. Application of one or more of these techniques at a landfill will be a function of the degree of protection of ground and surface water necessary at the specific site of a landfill disposal facility. There are two extreme approaches to landfill leachate management. One extreme involves complete reliance upon attenuation capabilities of the natural hydrogeologic system which incorporates biological, chemical and physical systems, including dilution, to abate the impact of leachate on ground and surface water. This approach requires a full understanding of the subsurface conditions at a landfill disposal site from the natural ground surface, at least, to the bottom of the uppermost saturated zone and a soundly based estimate of the anticipated landfill leachate quality and rate of generation. Analysis must demonstrate that the attenuation capability of soils in the unsaturated zone and dilution capacity of the saturated zone are sufficient to maintain the required ground and surface water quality for this approach to be utilized. The other extreme involves the maximum containment of landfill leachate by various techniques. Either approach requires a case-by-case evaluation. Since these approaches are the extremes, actual practice at a specific site will usually require a leachate management approach somewhere in between.

**§ 241.202-2 Recommended practices.**

Leachate control, when necessary in accordance with site design, should be accomplished through application of one or more of the following practices:

(a) Unless underlying ground water is determined to be unusable as a drinking water or other supply source and therefore not in need of protection, the bottom of a landfill disposal facility should be substantially (1.5 meters or more) above the seasonal high ground-water table, to prevent direct contact of disposed solid waste and the ground water. Depending upon the site design and degree of ground-water protection required, the unsaturated zone, between the water table and landfill bottom, can be equipped with monitoring devices to monitor the passage of leachate, if any, through this zone; or, relied upon to provide, at least, minimal attenuation of planned or unplanned escape of landfill leachate. In high groundwater table areas it may be necessary to lower the water table.

(b) Since the flow of surface water on a landfill can result in cover soil and solid waste erosion, as well as increased leachate generation, there should be no uncontrolled hydraulic connection between the landfill and standing or flowing surface water.

(1) Surface runoff diversion structures should be constructed surrounding the landfill capable of diverting away from the landfill all of the surface water runoff from the upland drainage area from the 10 year 24 hour precipitation event.

(2) A dike with sufficient structural integrity should be constructed around any landfill disposal facility located within the 100-year floodplain of sufficient height to prevent inundation. Subsurface controls may also be necessary to prevent instrusion of water resulting from the temporary elevated ground-water table during flooding.

(c) Similar to surface runoff from surrounding areas, incident precipitation (e.g. rain or snow) falling onto a

landfill can result in two effects, namely, increased leachate generation and erosion of cover soil and solid waste. Techniques to carry incident precipitation from the landfill without causing erosion should be applied, as follows:

(1) The final cover of the landfill should be graded such that water does not pool over the landfill. In order to minimize soil erosion the final grade should not exceed 30%. Slopes longer than 7.5 meters (25 feet) may require additional erosion control measures, such as, construction of horizontal terraces, of sufficient width for equipment operation, for every 6 meters (20 feet) rise in elevation. Minimum slope, including terraces, should be 2%.

(2) The final soil cover on a completed landfill disposal facility should be seeded or otherwise vegetated to minimize erosion and maximize evapotranspiration.

(3) If landfill site design incorporates minimization of leachate generation a low permeability cover soil with a low swell and shrink tendency upon wetting and drying should be utilized to avoid cracking.

(4) If landfill site design allows infiltration of incident precipitation or recirculation of leachate to encourage waste stabilization a suitably high permeability cover soil should be utilized to avoid ponding.

(5) The cover material selected should provide for a balance among the major functions of:

(i) Vehicle traffic
(ii) Water infiltration control
(iii) Gas migration control
(iv) Fire resistance
(v) Erosion control
(vi) Vector control
(vii) Support of vegetation

(d) The design of all landfill disposal facilities should be accomplished only after careful consideration of site hydrogeologic conditions which are to be relied upon, in part, for minimization of the impact of the anticipated quantity and quality of landfill leachate upon ground and surface water.

These considerations include an estimate of the attenuation capabilities of site soils and the quantity and quality of ground and surface water. The degree of reliance upon natural site hydrogeologic conditions depends upon the degree of protection required for underlying ground water. Protection of an underground water supply aquifer can be accomplished as follows:

(1) Where natural hydrogeologic conditions are sufficient to ameliorate the impact of leachate upon underlying ground water no bottom control, beyond naturally occurring soil layers, is necessary. Control of infiltrating incident precipitation through selection and placement of low permeability cover soil can reduce the total quantity of leachate which will enter the ground water.

(2) Where natural hydrogeologic conditions are unable to ameliorate the impact of the total quantity of leachate (as it is formed) upon underlying ground water, the bottom (and sides below natural grade) of the landfill should be lined with low permeability soil or other suitable material. The function of liner material is threefold: to delay the escape of leachate from the bottom of the liner for a period of time equal to the thickness of the liner divided by the liner permeability; to control the rate of escape of leachate from the bottom of the liner which must then be ameliorated by attenuation or dilution by underlying soils or ground water; and to provide some degree of attenuation as leachate passes through the liner material. The quantity of leachate which must be handled by the liner can be minimized through selection and placement of low permeability cover soil to reduce the infiltration of incident precipitation.

(3) Where natural hydrogeologic conditions can provide only minimal amelioration of the impact of leachate upon underlying ground water it is necessary to minimize the amount of leachate which is given the opportunity to enter the underlying soils by constantly removing, by drainage, the leachate which is intercepted by the liner material. This may be coupled with minimization of infiltrating incident precipitation by selection and placement of low permeability cover soil.

(4) Where natural hydrogeologic conditions are virtually incapable of ameliorating the impact of any leachate upon underlying ground water and the underlying ground water is particularly valuable it is necessary to preclude the escape of leachate from the bottom of the landfill through placement of multiple liners and constant drainage systems. Interruption of the downward flow of leachate by placement of a slightly permeable liner, designed for continuous removal of leachate, and underlain by a significantly less permeable liner material, also designed for continuous removal of leachate, should preclude the escape of leachate from the bottom of the lower-most liner.

(e) Many types of material can function successfully as liners. The rate of passage of leachate through liner materials is a function of the measured permeability of the material and the depth (or head) of leachate on the liner. In general, the rate of flow increases with depth of leachate. The variety of liner materials available include:

(1) Naturally occurring materials such as clays.

(2) Amended natural materials such as soil cements.

(3) Artificial materials such as asphaltic materials and polymeric membranes.

(f) Liner materials which are to significantly restrict the rate of flow of leachate from the bottom of a landfill should have the following properties:

(1) Permeability of $1\times10^{-7}$ cm/sec (about 0.1 foot/year) or less.

(2) Ability to resist physical and chemical attack by leachate.

(3) Be capable of maintaining integrity for the design life (which must be determined on a site-specific basis).

(g) The minimum allowable thickness for both natural and artificial liner materials is determined by either the degree of quality control and construction practice for liner placement, or the thickness necessary to provide a suitable structure to achieve the desired volumetric release of leachate for the maximum leachate storage anticipated, in accordance with the approved landfill design.

(1) The practical minimum thickness for natural soil liners in 30 cm (12 inches) and

(2) The practical minimum thickness for synthetic membrane liners is twenty (20) mils

(h) Artificial liner material, if selected, should be placed upon a carefully prepared base of selected material which will prevent liner puncture while providing uniform support, and should be covered with suitable material that will further protect the liner from damage and provide a drainage blanket for the leachate collection system. Approximately 60 cm (2 feet) of material is effective in protecting a liner from mechanical damage (puncture). The lowest 15 cm (6 inches) of material should be highly permeable to allow the leachate collection system to function properly.

(i) Removal of leachate collected on a liner should be incorporated into the the design of a lined landfill to avoid surface seeping and relieve hydraulic pressure on the liner. To facilitate leachate removal, liner materials should be sloped to one or more points and covered with a layer of highly permeable material such as pea gravel. A grade of 1% or more should be utilized.

(j) Once collected, landfill leachate should be disposed to the land or surface water in an environmentally sound manner to protect surface and ground-water quality. (Section 402 of Pub. L. 92-500 as amended by the Clean Water Act of 1977 (33 U.S.C. 1251) requires a permit for the discharge of collected leachate to surface water). Leachate treatment and disposal should be performed in accord-

ance with the following recommendations:

(1) Municipal solid waste landfill leachates have generally been shown to be treatable by various wastewater treatment techniques as follows:

(i) Leachate treatability—

| Leachate Quality | | Treatment Efficiency+ | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age of fill | COD, mg/l | Biological | Chemical Precipitation | Chemical Oxidation | Ozonation | Reverse Osmosis | Activated Carbon | Ion Exchange |
| Young (<5 yr) | >10,000 | G | P | P | P | F | P | P |
| Medium (5 yr-10 yr) | 500-10,000 | F | F | F | F | G | F | F |
| Old (>10 yr) | <500 | P | P | F | F | G | G | F |

CHIAN, E.S.K. and F.B. DeWALLE. Sanitary Landfill Leachates and their Treatment. Proceedings ASCE, Journal of the Environmental Engineering Division 102, EE2, 411-31. 1976.

+(COD removal: G=good, F=Fair, P=poor)

(ii) Leachate containing a significant fraction of biologically refractory high molecular weight organic compounds (i.e. those in excess of 50,000) are best treated by physical/chemical methods such as lime addition followed by settling.

(iii) Leachates containing primarily low molecular weight organic compounds are best treated by biological methods such as activated sludge.

(iv) Leachate treatment by combinations of chemical, physical and biological methods may be required to achieve discharge standards.

(2) Raw or treated landfill leachate should be discharged into a municipal or industrial wastewater treatment system only if this discharge will not impede the operation of the wastewater treatment system. Limited experience has shown that when raw municipal solid waste leachate volume exceeds about 5 percent of the total wastewater treatment plant flow, interruption of biological treatment processes may occur.

(3) Raw or treated leachate can be disposed by controlled application onto the surface of the land provided sufficient acreage is available and hydrology, soil type, vegetation, topography and climate for leachate disposal have been considered and surface or ground-water contamination will not occur.

(4) Recirculation of collected landfill leachate onto active or completed sections of the landfill can reduce leachate constituent concentrations by chemical, physical and biological processes and may be effective in reducing leachate volume. This technique can result in, at least, partial stabilization of young (0-5 years) landfill leachates which are relatively concentrated in comparison with rather old stabilized landfill leachates.

**§ 241.203 Gas control.**

**§ 241.203-1 General.**

Control of gases from a landfill disposal facility may be accomplished by techniques which: minimize the production of decomposition gases or occurrence of other harmful gases; control the escape of gases into the atmosphere; and minimize the migration of gases into soils surrounding the site.

**§ 241.203-2 Recommended practices.**

Gas control should be accomplished in accordance with the following:

(a) Leachate and runoff control measures which are intended to minimize the infiltration of water into a solid waste landfull may also reduce gas generation, primariliy $CH_4$ and a $CO_2$, resulting from decomposition of disposed organic solid waste.

(b) Volatile solid waste materials or wastes with a known high potential for release of harmful gases as a result of chemical reaction should not be accepted for disposal at a landfill disposal facility where such gases are required to be minimized or avoided.

(c) Encapsulation of solid waste in a landfill (e.g. low permeability liner and final cover) to prevent or minimize infiltrating water should be coupled with an effective ventilation system to remove decomposition gas from the land fill, as necessary.

(d) If a relatively porous material is used for cover at a landfill, which does not impede infiltrating water, gases should migrate vertically out of the landfill surface, except when frozen or saturated, for dissipation into the atmosphere. However, deep landfills may experience gas pressure buildup, regardless of cover used.

(e) Since horizontal migration of gases from landfills (due to both diffusion and pressure gradients) through surrounding soils is not uncommon, an analysis of the land area surrounding the landfill proper should be performed utilizing techniques for estimating fas flow through porous media. For shallow landfills a "rule of thumb" for estimating potential gas migration is a distance equal to ten (10) times the maximum depth of the landfill below original grade. If nearby underground utilities exist, additional examination along the utility corridor should be performed.

(f) Passive barriers which may be considered for the prevention of horizontal migration of gases include:

(1) Cutoff walls constructed of naturally occurring materials, such as com-

pacted moist clays, or artificial materials, such as asphaltic or polymeric materials. (i) To assure effectiveness the cutoff wall should extend from the ground surface down to a gas inpervious layer (e.g. bedrock or ground water) below the bottom of the landfill. (ii) Even though polymeric materials may be virtually impermeable to water the should be evaluated for permeability to gases.

(iii) Even when compacted, clays and other soils are impermeable to gases only when water saturated.

(iv) Once in place, properly constructed cutoff walls should require no maintenance.

(2) Venting systems, frequently used in the past, installed either on or off the landfill proper, consist of either gravel-filled trenches, perforated pipes, or both.

(i) Perforated pipes have been shown to be of limited effectiveness except in the immediate vicinity of the pipe and are therefore not recommended for reduction of pressure in a landfill, when used alone.

(ii) Gravel-filled trenches, while generally more effective than perforated pipes, still permit some migration of gases across the trench, especially when covered by snow or ice.

(iii) Gravel-filled trenches equipped with vertical perforated pipes have been shown to reduce the effect of temporary covers such as ice or snow but remain of limited effectiveness in landfill gas migration control.

(iv) Gravel-filled trenches must usually be equipped for removal of water or leachate from the trench bottom and are susceptible to plugging by biomass buildup.

(3) Combination passive barriers installed off the landfill, which consist of gravel-filled trenches in combination with an impermeable barrier installed on the side of the trench opposite the landfill, provide good protection against horizontal gas migration when keyed to a gas impermeable strata below the landfill.

(g) Active barriers which may be considered for the prevention of horizontal migration of gases include:

(1) Induced exhaust wells, consisting of several wells on or off the landfill equipped with perforated pipes connected to a pump or blower by a common header pipe.

(i) Such systems are very effective when properly designed and installed.

(ii) Such systems are not limited to shallow landfills or shallow impermeable substrata.

(iii) Exhaust gases may be "flared" or recovered.

(iv) Such systems may require significant maintenance.

(2) Induced exhaust trenches, consisting of surface sealed gravel-filled trenches equipped with perforated header pipes connected to a pump or blower.

(i) Such systems are more effective for controlling gas movement than exhaust wells, especially at shallow landfills, but require more extensive construction.

(ii) Such systems may require significant maintenance.

(iii) Use with recovery systems is unlikely due to introduction of air.

(3) Induced recharge trenches are of the same desisgn as induced exhaust trenches but operate in reverse, suppressing horizontal migration through introduction of air, under pressure, into the trench.

(i) Such systems have lower power requirements than exhaust trenches.

(ii) A gas flare is not necessary since gases are not concentrated.

(iii) Such systems rely upon dispersion of gases to the atmosphere across the trench and ground surface.

### § 241.204 Runoff control.

### § 241.204-1 General.

Control of surface water runoff at a landfill disposal facility is necessary in order to minimize the potential for environmental damage to ground and surface waters by direct and indirect effects. Direct surface water contamination can result from solid waste and other dissolved or suspended contaminants carried by surface runoff. Uncontrolled surface runoff can also contribute to leachate (and gas) generation thereby increasing the potential for both surface and ground-water contamination.

### § 241.204-2 Recommended practices.

Surface water runoff control should be accomplished at a landfill disposal facility in accordance with the following:

(a) Landfill disposal facilities should be located where the potential for surface drainage onto the landfill from adjacent land is minimal.

(b) Landfill disposal facilities should be epuipped with suitable channeling devices, such as ditches, berms or dikes, to divert surface runoff from the land area contiguous to the landfill.

(c) Incident precipitation at a landfill will either evaporate, runoff or infiltrate. To minimize leachate generation the final cover on the landfill should be graded to maximize runoff with due concern for erosion. The landfill surface should be sloped to grades less than 30% to enhance runoff without causing erosion problems. Vegetation of the sloped landfill surface will also minimize erosion of cover soil.

(d) Well-compacted, fine-grained soils should be used for final cover to enhance runoff while minimizing infiltration.

(e) Runoff not contaminated by solid waste or by leachate from seeps should be routed to a settling basin to remove sediment before discharge to a receiving stream. Other sedimentation control measures may be equally effective.

### § 241.205 Operation.

### § 241.205-1 General.

Proper site selection and design alone are insufficient to result in a landfill which provides for the protection of public health and the environment. To achieve such protection, operation of a landfill should be based upon the Recommended Practices of these Guidelines or other equivalent practices.

### § 241.205-2 Recommended practices.

A facility for the landfill disposal of solid waste should be operated in accordance with the following:

(a) In general, only wastes for which the facility has been specifically designed should be accepted for disposal; however, other wastes may be accepted if it has been demonstrated to the responsible agency that they can be satisfactorily disposed within the design capability or after appropriate facility modifications.

(1) Specific wastes, whose chemical, biological or physical characteristics are not compatible with the disposal site design, location or operation and which could pose an unacceptable environmental or health effect or pose a threat to the safety of personnel or users of the facility, should be prohibited from acceptance for disposal.

(2) Regulations promulgated pursuant to Subtitle C of the Act restrict the receipt of manifested hazardous wastes for disposal at a landfill to those facilities which are permitted in accordance with the Subtitle C regulations.

(3) Facility design features may require prohibition or pretreatment of certain solid wastes. For example, unless the facility incorporates a leachate control system with sufficient capability to accept liquid or semi-solid wastes, such receipt may need to be prohibited or materials such as water treatment sludges may require dewatering before acceptance.

(b) Cover material should be applied, if necessary, to minimize fire hazards, odors, blowing litter, vector food and harborage; control gas venting and infiltration of precipitation; discourage scavenging; and provide an aesthetic appearance.

(1) A minimum of 15cm. (6 inches) of soil cover material should be applied daily.

(2) Cells which will not have additional wastes placed on them for three months or more should be covered with 30cm. (12 inches) of cover material.

(3) Most soil materials can satisfy the purposes of cover soil. However, if minimization of infiltration is necessary, relatively low permeability cover material should be utilized and placed at the steepest practicable grade in order to encourage runoff. Low permeability soils will remain effective only if the soil has a low shrink-swell potential or if the soil moisture can be maintained to prevent cracks from shrinkage and swelling.

(4) The completed landfill should be covered with 15cm (6 inches) of clay or other suitable material with permeability equal to or less than $1 \times 10^{-7}$ cm/sec or equivalent, followed by a minimum cover of 45cm (18 inches) of additional soil to complete the final cover and support vegetation. Deeply rooted vegetation may require an even greater depth of suitable soil.

(c) In order to conserve landfill disposal site capacity and preserve land resources solid wastes should be incorporated into the landfill in the smallest practicable volume.

(1) For most solid waste materials landfill compaction equipment is necessary for volume reduction.

(2) Compaction or other volume reduction may take place at or before delivery to the landfill, by utilizing balers, shredders, or stationary compactors.

(3) Compaction of solid waste and cover soil reduces the attraction of rodents and vectors and the potential for fires.

(4) Open burning of solid waste for volume reduction should not be practiced at landfill disposal facilities.

(d) The landfill disposal facility should be designed, constructed and operated in a manner so as to protect the health and safety of personnel and users through strict supervision of operations and site access.

(1) A safety manual should be available for use by employees, and they should be instructed in application of its procedures.

(2) Personal safety devices such as hard hats, gloves, safety glasses, and footwear should be required for facility employees.

(3) Safety devices, including but not limited to such items as rollover protective structures, seat belts, audible reverse warning devices, and fire extinguishers should be provided on all equipment used to spread and compact solid wastes or cover material at the facility.

(4) Provisions should be made to extinguish any fires in wastes being delivered to the site or which occur at the working face or within equipment or personnel facilities.

(5) Communications equipment should be available on site for emergency situations.

(6) Scavenging should be prohibited at all times to avoid injury and to prevent interference with site operations, although controlled salvaging operations may be permissible.

(7) Access to the site should be controlled and should be only by established roadways. The site should be accessible only when operating personnel are on duty. Large containers may be placed at the site entrance so that individuals can conveniently deposit waste. The containers and the areas around them should be maintained in a sanitary and litter-free condition.

(8) Traffic signs or markers should be provided to promote an orderly traffic pattern to and from the discharge area, and maintain efficient operating conditions.

(e) Disease and nuisance vectors should be controlled at the landfill disposal facility through minimization of food and harbourage and through initiation of additional control programs if vector populations become established.

(f) Quantitative and qualitative records of solid wastes received and location of disposal should be maintained and submitted to responsible authorities in accordance with specific reporting instructions.

(g) A source of water should be provided at the landfill disposal facility for fire and dust control and for employee convenience.

(h) A landfill disposal facility should be maintained in an aesthetic manner.

(i) Following closure of a completed landfill disposal facility a long term maintenance program should be initiated and continued for as long as deemed necessary by the appropriate regulatory authority.

### § 241.206 Monitoring.

### § 241.206-1 General.

Monitoring can be an essential activity in establishing, operating, and retiring a solid waste landfill disposal facility. Where possible, monitoring should be coordinated with State and areawide water quality management, monitoring and assessment activities.

### § 241.206-2 Recommended practices.

Solid waste landfill disposal facilities should be monitored as follows for the purposes of determining when contingency remedial action plans should be implemented.

(a) Ground-water and Leachate Monitoring.

(1) A ground-water monitoring system should be installed for the purpose of detecting the impact of all landfill disposal facilities which have the potential for discharge to an underground drinking water source.

(i) Publication EPA/530/SW-611 entitled "Procedures for Ground-water Monitoring at Solid Waste Disposal Facilities" should be consulted for additional information on this subject.

(2) In no case should ground-water or leachate monitoring wells be installed through the bottom of the landfill proper since such installation could result in creation of a conduit for the direct passage of landfill leachate into underlying ground water.

(3) Samples from the monitoring wells should be collected and analyzed prior to disposal of solid waste at a new landfill facility in order to obtain baseline data.

(4) Samples should be collected from all monitoring devices and analyzed at least once a year. The analytical methods specified in 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants" should be followed.

(b) *Facility structure monitoring.* (1) All enclosed structures at a solid waste landfill disposal facility should be monitored to detect accumulations of explosive or otherwise harmful gases which might pose a safety hazard to facility employees and users.

(2) Explosive gases, typically methane, should be monitored for presence in the explosive limits with an explosimeter.

(3) Toxic or asphyxiating gases should be monitored on a regular basis with appropriate instruments.

(c) Perimeter Soil Monitoring.

(1) Suitable probes should be installed in the soil at the property boundary surrounding the landfill to enable detection of gases migrating from the landfill.

(2) Explosive gases should be monitored for presence above the lower explosive limit.

(3) Toxic or asphyxiating gases should be monitored on a regular basis with appropriate instruments.

### § 241.207 Use of environmental impact statement.

### § 241.207-1 General.

As indicated previously in these Guidelines, selection of an alternative landfill technology option should occur only after consideration of the impact of companion technologies to be applied at a specific landfill disposal facility. An Environmental Impact Statement has been developed concurrently with these Guidelines to provide an in-depth discussion of the impacts and economics associated with landfill-related unit processes.

**§ 241.207-2 Recommended practices.**

Following review of the recommended practices and considerations of these Guidelines to enable selection of appropriate control technologies for a new or modified existing landfill disposal facility, the Environmental Impact Statement on these Guidelines should be reviewed to assist in achieving a better understanding of the economics and technological implications of unit process selection. The Environmental Impact Statement is organized such that landfill-related unit processes are discussed in relation to the appropriate Sections of these Guidelines. Since the Environmental Impact Statement is focused on unit process discussions, §§ 241.200 Site Selection and 241.201 Design are not specifically addressed in these discussions but, of course, are related in a general manner throughout. The remaining Sections of these Guidelines are addressed and inter-related in the Environmental Impact Statement as follows:

(a) Landfill-related unit processes which singly or in combination with other processes may achieve leachate control are discussed in the following Sections of the Environmental Impact Statement:

4.4 Surface Runoff Diversion
4.5 Grading
4.6 Diking
4.8 Daily and Final Cover
4.9 Synthetic Liners
4.10 Natural Clay Liners
4.11 Leachate Collection
4.12 Leachate Treatment
4.13 Leachate Recycling
4.24 Leachate Monitoring
4.25 Revegetation

(b) Landfill-related unit processes which singly or in combination with other processes may achieve gas control are discussed in the following Sections of the Environmental Impact Statement:

4.4 Surface Runoff Diversion
4.5 Grading
4.6 Diking
4.8 Daily and Final Cover
4.9 Synthetic Liners
4.10 Natural Clay Liners
4.14 Impermeable Barriers
4.15 Permeable Trenches
4.16 Vertical Risers
4.17 Gas Collection Systems
4.23 Gas Monitoring

(c) Landfill-related unit processes which singly or in combination with other processes may achieve runoff control are discussed in the following Sections of the Environmental Impact Statement:

4.4 Surface Runoff Diversion
4.5 Grading
4.6 Diking
4.7 Ponding
4.8 Daily and Final Cover
4.25 Revegetation

(d) Landfill-related unit processes which singly or in combination with other processes may achieve satisfactory operation (in addition to unit processes related to other control technologies) are discussed in the following Sections of the Environmental Impact Statement:

4.1 Compaction
4.2 Shredding
4.3 Baling
4.8 Daily and Final Cover
4.18 Access Control
4.19 Safety
4.20 Fire Control
4.21 Vector Control
4.22 Litter Control
4.25 Revegetation

(e) Landfill-related unit processes which singly or in combination with other processes may achieve satisfactory monitoring are discussed in the following Section of the Environmental Impact Statement:

4.23 Gas Monitoring
4.24 Leachate Monitoring

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